

Applicant: Elliott et al.
For: Scanning Plasma Reactor

- 1 1. A scanning plasma reactor for exciting or ionizing reactant gases with UV
2 radiation at a substrate surface comprising:
3 a beam forming module to transform a UV radiation source raw output into a
4 rectangular beam;
5 a gas injection module to deliver at least one reactant gas to the substrate surface;
6 a reaction chamber with a UV window through which said beam forming module
7 projects said rectangular beam;
8 a vacuum chuck for holding a substrate; and
9 a gas exhaust module inside said chamber to remove reaction by-products and
10 unreacted reactant gas from the substrate surface,
11 wherein said gas injection module and said gas exhaust module are in close
12 proximity to said rectangular beam, and wherein said rectangular beam, said gas injection
13 module and said gas exhaust module are movable relative to the substrate surface.
- 1 2. The scanning plasma reactor of claim 1 wherein said UV radiation source raw output
2 is in the wavelength range of 351nm to 157nm.
- 1 3. The scanning plasma reactor of claim 1 wherein said rectangular beam has
2 dimensions of approximately 200-300mm in length and 0.1-10mm in width.
- 1 4. The scanning plasma reactor of claim 1 wherein said rectangular beam has an energy
2 level at the substrate surface in the range of about 0.1-10 Joules/cm².

1 5. The scanning plasma reactor of claim 1 wherein said beam forming module consists
2 of a plurality of optical elements.

1 ^{508A₂} > 6. The scanning plasma reactor of claim 5 wherein said beam forming module consists
2 of at least two cylindrical ~~refractive~~ refractive elements.

1 7. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 create an etching reaction on the substrate surface.

1 8. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 create a deposition reaction on the substrate surface.

1 9. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 create an oxidation reaction on the substrate surface.

1 10. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 create a reduction reaction on the substrate surface.

1 11. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 create a melting reaction on the substrate surface.

1 12. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 modify the surface of a metallic or non-metallic film on the substrate surface.

1 13. The scanning plasma reactor of claim 1 wherein the reactant gases are combined with

1 20. The scanning plasma reactor of claim 1 wherein said UV window is located on the
2 top of the reaction chamber.

1 21. The scanning plasma reactor of claim 1 wherein said UV window is located on
2 one side of the reaction chamber.

1 22. The scanning plasma reactor of claim 1 wherein said reaction chamber is at
2 atmospheric pressure.

1 23. The scanning plasma reactor of claim 1 further comprising an electronic control
2 module to programmably select a reactant gas chemistry and an excitation energy level
3 for one or more processes selected from etching, deposition, doping, ion implantation, re-
4 crystallization, UV curing, oxidation, surface roughening, photochemical modification,
5 and reduction reactions.

1 24. The scanning plasma reactor of claim 1 wherein the substrate surface is
2 transparent to said rectangular beam and said rectangular beam causes a reaction at a
3 layer of the substrate below the substrate surface.

1 25. The scanning plasma reactor of claim 1 wherein the reactant gases are reacted to
2 create a doping reaction on the substrate surface.

1 26. The scanning plasma reactor of claim 1 wherein said vacuum chuck includes a
2 heating element to heat the substrate.

1 27. The scanning plasma reactor of claim 1 wherein said beam forming module
2 includes a mirror which is adjustably positionable to change the angle of said rectangular
3 beam relative to the substrate surface.

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1 28. A scanning plasma reactor for exciting or ionizing reactant gases with UV
2 radiation at a substrate surface comprising:
3 a beam forming module to transform a UV radiation source raw output into a
4 rectangular beam;
5 a gas injection module to deliver at least one reactant gas to the substrate surface;
6 a reaction chamber with a UV window through which said beam forming module
7 projects said rectangular beam; and
8 a gas exhaust module inside said chamber to remove reaction by-products and
9 unreacted reactant gas from the substrate surface,
10 wherein said gas injection module is fixed at one end of said chamber and said gas
11 exhaust module is fixed at an opposite end of said chamber relative to said gas injection
12 module and said rectangular beam is movable relative to the substrate surface.

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1 29. A scanning plasma reactor for exciting or ionizing reactant gases with UV
2 radiation at a substrate surface comprising:
3 a beam forming module to transform a UV radiation source raw output into a
4 rectangular beam;
5 a gas injection module to deliver at least one reactant gas and at least a second
6 fluid or vapor to the substrate surface;
7 a reaction chamber with a UV window through which said beam forming module
8 projects said rectangular beam; and
9 a gas exhaust module inside said chamber to remove reaction by-products and
10 unreacted reactant gas from the substrate surface,
11 wherein said rectangular beam and said at least one reactant gas form a reaction zone at or
12 near the substrate surface, said reaction zone being movable relative the substrate.

4 reaction chamber through which second beam forming module projects said second
5 rectangular beam.

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